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Inventor(s) or Application Identifier
Koichi SATO

Title: IMAGE READING DEVICE

ADDRESS TO:

 Assistant Commissioner for Patents
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 Washington, DC 20231

APPLICATION ELEMENTS

ACCOMPANYING APPLICATION PARTS

1. ☒ Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)
2. ☒ Specification [Total Pages 23]
(preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
- ☒ Drawing(s) (35 USC 113) [Total Sheets 6]
- ☒ Oath or Declaration [Total Pages 3]
 a. ☒ Newly executed (original or copy) ☐ Unexecuted
 b. ☐ Copy from a prior application (37 CFR 1.63(d))
 (for continuation/divisional with Box 18 completed)
 [Note Box 5 below]
 i. ☐ DELETION OF INVENTOR(S)
 Signed statement attached deleting inventor(s)
 named in the prior application, see 37 CFR 1.63(d)(2)
 and 1.33(b).
- ☐ Incorporation By Reference (useable if Box 4b is checked)
 The entire disclosure of the prior application, from which a copy
 of the oath or declaration is supplied under Box 4b, is considered
 as being part of the disclosure of the accompanying application
 and is hereby incorporated by reference therein.
- ☐ Microfiche Computer Program (Appendix)
- Nucleotide and/or Amino Acid Sequence Submission
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8. ☒ Assignment Papers (cover sheet & document(s))
9. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney
(when there is an assignee)
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure ☐ Copies of IDS Citations
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16. ☒ Foreign priority claimed
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17. ☐ Other: _____

18. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior Application No. _____/_____, filed _____.
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P18408.A01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Koichi SATO

Serial No : Not Yet Assigned

Filed : Concurrently Herewith

For : IMAGE READING DEVICE

PRELIMINARY AMENDMENT

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to calculation of the filing fees and the examination of the above-identified patent application on the merits, the Examiner is respectfully requested to amend the claims as follows:

IN THE CLAIMS

Please amend the claims as follows:

Claim 6, line 1, change "one of claims 4 and 5" to --claim 4--.

Claim 7, line 1, change "one of claims 4 and 5" to --claim 4--.


REMARKS

By the above amendment, claims 6 and 7 have been amended to delete multiple dependency.

P18408.A01

If there should be any questions, the Examiner is invited to contact the undersigned
at the telephone number listed below.

Respectfully submitted,
Koichi SATO

 Reg. No. 33,329
Bruce H. Bernstein
Reg. No. 29,027

November 30, 1999
GREENBLUM & BERNSTEIN, P.L.C.
1941 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

IMAGE READING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to an image reading device in which image data, having a multitude of pixel data, is obtained by an imaging device, and after a reading operation of the pixel data from the imaging device, some of the pixel data are thinned out.

10 2. Description of the Related Art

Conventionally, there is known an image reading device, such as a digital camera, in which image data is obtained by an imaging device such as a CCD, and a color image, corresponding to the image data, can be recorded in a recording medium. The
15 CCD is provided with an on-chip color filter, in which color filter elements of the three primary colors, for example, are provided on photo-diodes of the CCD. Namely, a pixel data generated by each of the photo-diodes corresponds to one of the primary colors, and thus, the pixel data does not indicate the
20 other primary colors. Thus, an interpolation process is performed to obtain pixel data of the other primary colors.

A number of pixel data, recorded in the recording medium, is determined depending upon a recording mode, and is usually much less than that of the photo-diodes. Therefore, in a
25 conventional device, after the interpolation process, some of

pixel data are thinned out to reduce the number of pixel data in conformity with the number of pixel data to be recorded in the recording medium.

Thus, in the conventional device, three image frame's
5 worth of color image data are generated because of the interpolation process, and the thinning process is then applied to the color image data. Namely, in the interpolation process and the thinning process, a large number of pixel data are processed, and therefore, it takes a long time to obtain the
10 pixel data to be recorded.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an image reading device by which the interpolation process and the thinning process are carried out in a reduced
15 time, in comparison with a conventional device.

According to the present invention, there is provided an image reading device comprising an imaging device, a reading processor, a thinning processor and an interpolation processor.

20 The imaging device has photo-diodes and color filters provided on the imaging device, the color filter having color filter elements of a plurality of colors. The photo-diodes generate an original image data containing pixel data, each of which corresponds to one of the colors which are arranged in a
25 predetermined distribution. The reading processor reads the

pixel data from the imaging device. The thinning processor thins out some of the pixel data to generate a thinned image data, colors of which are arranged in the predetermined distribution. The interpolation processor performs an interpolation process on
5 the thinned image data to generate an interpolated image data for each of the colors.

Further, according to the present invention, there is provided an image reading device in which pixel data of a first image, formed on an imaging device having an on-chip color filter
10 of a plurality of colors, are point-sequentially read from said imaging device and are subjected to an interpolation process to generate components of said plurality of colors for each of said pixel data to obtain a second image, the image reading device comprising a thinning processor that thins out some of the pixel
15 data before the pixel data are subjected to the interpolation process, so that said second image is composed of a smaller number of pixels than the first image.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood from the
20 description of the preferred embodiments of the invention set forth below, together with the accompanying drawings, in which:

Fig. 1 is a perspective view showing a digital camera which is an image reading device to which an embodiment of the
25 present invention is applied;

Fig. 2 is a block diagram showing electric circuits provided in the digital camera;

Fig. 3 is a view showing an arrangement of an on-chip color filter provided on an imaging device, or an arrangement of
5 color components of original image data read by the imaging device;

Fig. 4 is a view showing thinned image data, which have been subjected to a thinning process using a reduction ratio of $(1/3 \times 1/3)$ time;

10 Fig. 5 is a view showing thinned image data, which have been subjected to a thinning process using a reduction ratio of $(1/5 \times 1/5)$ time;

Fig. 6 is a view showing interpolated image data of the R component, which have been subjected to an interpolation
15 process after the thinning process using the reduction ratio of $(1/3 \times 1/3)$ time;

Fig. 7 is a view showing interpolated image data of the R component, which have been subjected to an interpolation
process after the thinning process using the reduction ratio of
20 $(1/5 \times 1/5)$ time; and

Fig. 8 is a flowchart of a recording routine, by which an image is indicated by a liquid crystal display and image data are recorded in a memory card.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 The present invention will be described below with

reference to embodiments shown in the drawings.

Fig. 1 shows a digital camera (i.e., an image reading device) 10 to which an embodiment of the present invention is applied. By the digital camera 10, a photographed color image can be recorded in a memory card (not shown) mounted in the camera 10. The color image is reduced with a predetermined reduction ratio, so that the reduced color image can be indicated by a liquid crystal display (LCD) 11.

The digital camera 10 is provided with a lens barrel 13 on a front surface 10a of the camera 10, and a photographing optical system 12 is held in the lens barrel 13. On a rear surface 10c of the camera 10, a view-finder (not shown) is provided.

The LCD 11 is provided on an upper surface 10b of the camera 10. A release button 16 is provided on the upper surface 10b. An operation panel 15 and an indication panel 17 are also disposed on the upper surface 10b. The operation panel 15 is provided with various kinds of operation buttons including a reduction ratio setting button, by which the reduction ratio of the color image is set, and a cancel button, by which an operation of the digital camera 10 is canceled. The reduction ratio setting button is constructed in such a manner that the reduction ratio is changed to one time, $(1/3 \times 1/3)$ time and $(1/5 \times 1/5)$ time, in this order, with every depressing operation of the button (i.e., whenever the button is depressed). The

indication panel 17 is a liquid crystal display, for example, in which numerals and a predetermined figure signifying the reduction ratio can be indicated.

With reference to Fig. 2, an electric construction of the digital camera 10 will be described below.

The operation panel 15, the release button 16 and the indication panel 17 are connected to a control unit 40 having a micro-computer. Operations of the digital camera 10 are performed by depressing various kinds of operation buttons provided in the operation panel 15 or the release button 16, and are controlled by the control unit 40.

An imaging device (CCD) 30 is mounted in the digital camera 10. Between the photographing optical system 12 and the CCD 30, a quick return mirror 21 and a shutter 22 are provided, the shutter 22 being disposed behind the quick return mirror 21. A view-finder optical system 23 is positioned above the quick return mirror 21.

The CCD 30 is an area sensor having a light receiving surface on which a multitude of photo-diodes are arranged, on which an on-chip color filter of the Bayer arrangement is provided. Namely, the color filter has color filter elements of the three primary colors, i.e., red (R), green (G) and blue (B), and thus, the photo-diodes generate an original image data comprising analog pixel data, each of which corresponds to one of the three primary colors.

The quick return mirror 21 can be rotated between an inclined state shown in a solid line and a horizontal state shown in a broken line. The quick return mirror 21 is usually positioned in the inclined state, so that light, passing through the photographing optical system 12, is led to the view-finder optical system 23. In this state, the shutter 22 is closed to block an optical path to the CCD 30. Conversely, when the release button 16 is depressed to perform a photographing operation, the quick return mirror 21 is rotated upward under control of a mirror drive circuit 24, and is set to the horizontal state. While the mirror 21 is positioned at the horizontal state, the shutter 22 is opened under control of a shutter drive circuit 25, and thus, light passing through the photographing optical system 12 enters a light receiving surface of the CCD 30.

A timing generation circuit 41 is connected to the control unit 40, so that a timing signal is generated by the timing generation circuit 41 under control of the control unit 40. Based on the timing signal, a CCD drive circuit 32, a correlated double sampling circuit (CDS) 42 and an A/D converter 43 are driven.

When the release button 16 is depressed, a photographing operation is performed. Namely, the CCD 30 is controlled by the CCD drive circuit 32, so that one image's worth of analog pixel data of R, G and B components are point-sequentially read from

the CCD 30, and reset noises are removed from the pixel data. Then, the analog pixel data are converted to digital pixel data by the A/D converter 43. The digital pixel data are stored in an image memory 45 through a digital signal processing circuit
5 (DSP) 44.

The digital pixel data are read from the image memory 45, and are subjected to a thinning process, by which a color image is reduced, in the DSP 44 to obtain thinned image data. The thinning process is carried out in accordance with a reduction
10 ratio which is set by the reduction ratio setting button provided in the operation panel 15. After the thinning process, the thinned image data are subjected to an interpolation process, so that interpolated image data of R, G and B components are generated in accordance with a color arrangement of the LCD 11.
15 The digital pixel data, subjected to the interpolation process, are subjected to predetermined processes including a color correction and a gamma correction, and then stored in a memory (not shown) provided in an LCD indication circuit 50. The digital pixel data, stored in the memory, are read therefrom
20 under control of the LCD indication circuit 50, so that a color image is indicated by the LCD 11 based on the digital pixel data, i.e., the interpolated image data.

When the image indicated by the LCD 11 is verified by the operator, and the release button 16 is again depressed, an image
25 recording operation is performed, which is described below. The

digital pixel data, which are stored in the image memory 45, have not been subjected to a thinning process and an interpolation process. When the digital pixel data are read from the image memory 45, the digital pixel data are subjected to the thinning process by the DSP 44, in accordance with a reduction ratio set by the operation panel 15 to obtain thinned image data. Then, the thinned image data are subjected to the interpolation process, so that interpolated image data of R, G and B components are generated for each of the pixels of the image. The interpolated image data are then converted to luminance data and color differential data by a memory card controller 62. The luminance data and the color differential data are then subjected to a predetermined process including a compression process, and are then stored in a memory card 60 through a memory card slot 61.

Note that the reduction ratio is usually set to 1, and when the image is not reduced, the digital pixel data, read from the image memory 45, are not subjected to the thinning process, but are subjected to the interpolation process.

With reference to Fig. 3, an output operation of pixel data from the CCD 30 is described below. On the light receiving surface of the CCD 30, an on-chip color filter of the Bayer arrangement is provided, in which red filter elements, green filter elements and blue filter elements are arranged as shown in Fig. 3. In the drawing, "R", "G" and "B" signify the colors

of the filter elements, and the suffixes "m" and "n" signify positions of the color filter elements.

In a row L_n , R filter elements and G filter elements are alternately arranged, and in a row L_{n+1} , G filter elements and B filter elements are alternately arranged. In rows below the row L_{n+1} , the color filter element arrangement of the row L_n and the color filter element arrangement of the row L_{n+1} are alternately repeated. In other words, rectangular R, G and B filter elements are repeatedly arranged in a horizontal direction H and in a vertical direction V, with a minimum unit of a 2 x 2 matrix M. In the matrix M, two green filter elements are positioned on a diagonal line, and a red filter element and a blue filter element are positioned on another diagonal line.

Each of the color filter elements corresponds to each of the photo-diodes provided on the light receiving surface of the CCD 30. Therefore, by each of the photo-diodes, a pixel data, corresponding to the color of the filter element provided on the photo-diode, is sensed. Pixel data sensed by the photo-diodes are point-sequentially output from the CCD 30. In this output operation, after the pixel data corresponding to the row L_n are output, the pixel data corresponding to the row L_{n+1} are output. Thus, the pixel data are output point by point in each successive row. Therefore, an order, in which each of the pixel data of R, G and B is output, is the same as an order in which each of the color filter elements is arranged as shown in Fig. 3, and in an

image formed by pixel data output from the CCD 30, each of the R, G and B components is repeatedly arranged with the unit of 2 x 2 matrix M. In the following description, since the color arrangement of the image is the same as that of the color filter of the Bayer arrangement, it is supposed that Fig. 3 indicates the image, and the suffixes "m" and "n" indicate the output order of the pixel data, i.e., positions of pixel data in the image.

The original image data output from the CCD 30 are subjected to a predetermined process as described above, and are stored in the image memory 45 as digital pixel data. Addresses of the image memory 45, in which the digital pixel data of R, G and B components are stored, correspond to the positions of the original image data output from the CCD 30. The digital pixel data are read from the image memory 45, and are then subjected to a thinning process so that the image is reduced, as will be described below with reference to Figs. 3 through 5.

The thinning process is performed in such a manner that an arrangement of R, G and B components of the thinned image data, remains identical with that of the digital pixel data which are not subjected the thinning process, so that, after the thinning process, an interpolation process can be performed in a conventional method. Therefore, when the color components of the original image data, output from the CCD 30, are arranged in such a manner that a (m x m) matrix, formed by said plurality of colors, is repeated, the image can be reduced with a reduction

ratio S indicated by a formula (1).

$$S = (1/(m \times (n-1)+1)) \times (1/(m \times (n-1)+1)) \dots (1)$$

wherein "n" is an arbitrary positive integer greater than 1. In the thinning process, $(m \times (n-1))$ number of pixel data are
5 thinned out for every $(m \times (n-1)+1)$ number of pixel data in a horizontal direction H and a vertical direction V of the image, in accordance with the reduction ratio indicated by the formula (1).

In the embodiment, since "m" is 2, the image can be
10 reduced with the reduction ratio S of $(1/3 \times 1/3)$ time (i.e., $n=2$) and $(1/5 \times 1/5)$ time (i.e., $n=3$), for example. Namely, as the reduction ratio, one time (i.e., without reduction), $(1/3 \times 1/3)$ time and $(1/5 \times 1/5)$ time can be selected.

An example, in which the thinning process is performed
15 with the reduction ratio of $(1/3 \times 1/3)$, is described below. In this case, "m" is 2 and "n" is 2 in the formula (1), and thus, 2 pixel data are thinned out for every 3 pixel data in the horizontal direction H and the vertical direction V of the image. Namely, pixel data of R, G and B components positioned in a
20 rectangle shown by broken lines P3 in Fig. 3. In other words, only pixel data $(R_{m,n}, G_{m,n+3}, G_{m+3,n}, B_{m+3,n+3})$, for example) which are not enclosed by the broken lines P3 are read from the image memory 45 so that the thinning process is carried out. If a reduced image is formed by the pixel data, which have been
25 subjected to the thinning process, the arrangement of R, G and

B components of the reduced image is, as shown in Fig. 4, the same as that of the image, formed by the digital pixel data without thinning. Namely, in the reduced image, the color components are arranged in such a manner that a (2 x 2) matrix M is repeated.

An example, in which the thinning process is performed with the reduction ratio of (1/5 x 1/5), is described below. In this case, "m" is 2 and "n" is 3 in the formula (1), and thus, 4 pixel data are thinned out for every 5 pixel data in the horizontal direction H and the vertical direction V of the image. Namely, pixel data of R, G and B components positioned in a rectangle shown by chained lines P5 in Fig. 3. In other words, only pixel data ($R_{m,n}$, $G_{m,n+5}$, $G_{m+5,n}$, $B_{m+5,n+5}$, for example) which are not enclosed by the chained lines P5 are read from the image memory 45 so that the thinning process is carried out. If a reduced image is formed by the pixel data, which have been subjected to the thinning process, the arrangement of R, G and B components of the reduced image is, as shown in Fig. 5, the same as that of the image, formed by the pixel data without thinning. Namely, in the reduced image, the color components are arranged in such a manner that a (2 x 2) matrix M is repeated.

Fig. 6 shows pixel data of the R component, which have been subjected to an interpolation process after the thinning process using the reduction ratio of (1/3 x 1/3) time, and Fig. 7 shows pixel data of the R component, which have been subjected

to an interpolation process after the thinning process using the reduction ratio of $(1/5 \times 1/5)$ time. In Figs. 6 and 7, the pixel data, to which a mark "*" is attached, is obtained by the interpolation process, in which the marked pixel data is
5 calculated using pixel data positioned around the marked pixel data, and which is the same process as in a conventional device, since the positional relationship of R, G and B components in the reduced image is identical with that of the image, which is formed by pixel data without thinning. Namely, the marked pixel
10 data is obtained by using adjacent pixel data, in such a manner that the adjacent pixel data are each multiplied by a weight coefficient, the resultant values are then totaled together, and then divided by the number of the adjacent pixel data, to obtain the marked pixel data.

15 The interpolation process is performed for each of the R, G and B components, and thus, the pixel data of the reduced image composed of a single color component are obtained for each of the R, G and B components. The number of pixel data, which have been subjected to the thinning process, is less than that of pixel
20 data, not subjected to the thinning process. Therefore, since the interpolation process is carried out for a reduced number of pixel data, the process time of the interpolation process is reduced in comparison with a conventional device.

Fig. 8 shows a flowchart of a indication/recording
25 routine, which is executed in the control unit 40 so that an

image is indicated by the LCD and image data are recorded in the memory card 60. The image is reduced with a reduction ratio which is set by the reduction ratio setting button provided in the operation panel 15.

5 In Step 110, it is determined whether the release button 16 is depressed. Step 110 is executed until it is determined the release button 16 has been depressed, and when the release button 16 is depressed, i.e., when a photographing operation is started, the process goes to Step 120.

10 In Step 120, the CCD 30 is activated, so that pixel data of R, G and B components of an image to be photographed are sensed by the CCD 30. The pixel data are subjected to a predetermined process, and stored in the image memory 45 as digital pixel data, in which addresses, in which the digital
15 pixel data are stored, correspond to the arrangement of colors of the digital pixel data in the image, shown in Fig. 3.

 In Step 140, the reduction ratio, $(1/5 \times 1/5)$ time, for example, which has been set by the operation panel 15, is read, and positions of pixel data, which are not to be thinned out, are
20 calculated so that the image is reduced in accordance with the reduction ratio. In Step 150, only the pixel data corresponding to the calculated positions are read from the image memory 45, by which the thinning process is completed. In Step 155, an interpolation process is performed to the thinned image data read
25 in Step 150, so that interpolated image data of R, G and B

components are generated for each pixel of the reduced image, respectively, and are stored in a memory provided in the LCD indication circuit 50. Due to Steps 150 and 155, the pixel data for indication of the image by the LCD 11 are generated.

5 In Step 160, the interpolated image data of R, G and B components are read from the memory of the LCD indication circuit 50, and based on the interpolated image data, the reduced image is indicated by the LCD 11.

10 A loop formed by Steps 170 through 190 is executed until either one of the reduction ration setting button and the cancel button, which are provided in the operation panel 15, and the release button 16 is depressed, or the process does not proceed.

15 In Step 170, it is determined whether the reduction ratio has been changed. The user can check the reduced image indicated by the LCD 11, and can depress the reduction ratio setting button of the operation panel 15 to change the reduction ratio. When it is determined in Step 170 that the reduction ratio has been changed, the process goes back to Step 140, so that the image is
20 indicated by the LCD 11 with the changed reduction ratio. Conversely, when it is determined in Step 170 that the reduction ratio has not been changed, the process goes to Step 180.

25 In Step 180, it is determined whether the cancel button of the operation panel 15 has been depressed. When it is determined that the cancel button has been depressed, i.e. when

the pixel data should not be recorded in the memory card 60, the indication/recording routine ends. Conversely, when it is determined that the cancel button has not been depressed, Step 190 is executed.

5 In Step 190, it is determined whether the release button 16 has again been depressed, i.e., whether the pixel data should be recorded in the memory card 60. When it is determined in Step 190 that the release button 16 has not been depressed, Step 170 is again executed. Conversely, when it is determined that the
10 release button 16 has been depressed, Step 200 is executed, in which only the pixel data, corresponding to the positions calculated in Step 140, are read from the image memory 45, by which the thinning process is completed to obtain thinned image data. The read thinned image data are subjected to an
15 interpolation process in Step 205, so that interpolated image data of R, G and B components are generated, as described above. In Step 210, the interpolated image data of the color components are converted to luminance signals and color differential signals, and are then subjected to a predetermined process such
20 as a data compression. Then, the processed data are stored in the memory card 60 through the memory card controller 62, and thus the indication/recording routine ends. Due to Steps 200 and 205, the pixel data to be recorded in the memory card 60 are generated.

25 According to the embodiment, when an image is reduced

with a predetermined reduction ratio, firstly, a thinning process is performed prior to an interpolation process. Therefore, the number of pixel data, which are subjected to the thinning process, is equal to that of one image. Conventionally, when an
5 image is reduced with a predetermined reduction ratio, the thinning process is performed after the interpolation process. In this case, pixel data read from the CCD are subjected to the interpolation process, so that one image's worth of pixel data are obtained for each of the R, G and B components. Namely,
10 three image's worth of pixel data are generated. Therefore, three image's worth of pixel data are subjected to the thinning process, and the number of pixel data, to be processed, is great. In comparison, in the embodiment, the number of pixel data is not increased being prior to the interpolation process, and only one
15 image's worth of pixel data are subjected to the thinning process. Thus, a time required for the thinning process is reduced.

Further, in the embodiment, since the interpolation process is performed after the number of pixel data is reduced
20 by the thinning process, useless color pixel data, for pixels not included in the thinned image data, are not generated, and thus a calculation time for the interpolation process is shortened. In the interpolation process, one image's worth of pixel data are generated for each of R, G and B components. Namely, three
25 image's worth of color pixel data are generated. However, when

the interpolation process is performed, the number of pixel data has already been reduced to that of the reduced image, and therefore, the number of pixel data, which are handled in an image indicating operation and an image recording operation, is
5 decreased, so that a capacity of the memory provided in the LCD indication circuit 50 can be reduced.

Note that, although the on-chip color filter of the Bayer arrangement is provided in the embodiment, an on-chip color filter having the other arrangement, in which an (m x m) matrix
10 of color components is repeatedly arranged, can be utilized. Further, colors of the filter elements are not restricted to R, G and B, and two or more color filters elements can be used.

Although the embodiments of the present invention have been described herein with reference to the accompanying
15 drawings, obviously many modifications and changes may be made by those skilled in this art without departing from the scope of the invention.

The present disclosure relates to subject matter contained in Japanese Patent Application No. 10-341680 (filed on
20 December 1, 1998) which is expressly incorporated herein, by reference, in its entirety.

CLAIMS

1. An image reading device comprising:

an imaging device that has photo-diodes and color filters provided on said imaging device, said color filter having color filter elements of a plurality of colors, said photo-diodes generating an original image data containing pixel data, each of which corresponds to one of said colors which are arranged in a predetermined distribution;

a reading processor that reads said pixel data from said imaging device;

a thinning processor that thins out some of said pixel data to generate a thinned image data, colors of which are arranged in said predetermined distribution; and

an interpolation processor that performs an interpolation process on said thinned image data to generate an interpolated image data for each of said colors.

2. A device according to claim 1, wherein said colors of said original image data are arranged in such a manner that a $(m \times m)$ matrix, formed by said plurality of colors, is repeated, and said thinning processor thins out $(m \times (n-1))$ number of pixel data for every $(m \times (n-1)+1)$ number of pixel data in a horizontal direction and a vertical direction of an image corresponding to said original image data, wherein each of "m" and "n" is a positive integer greater than 1.

3. A device according to claim 2, wherein said colors of

said original image data are arranged in such a manner that a (2 x 2) matrix, formed by said plurality of colors, is repeated, and said thinning processor thins out (2 x (n-1)) number of pixel data for every (2 x (n-1)+1) number of pixel data in a horizontal direction and a vertical direction of an image corresponding to said original image data.

4. A device according to claim 3, wherein said thinning processor thins out 2 pixel data for every 3 pixel data.

5. A device according to claim 3, wherein said thinning processor thins out 4 pixel data for every 5 pixel data.

6. A device according to one of claims 4 and 5, wherein said colors of said color filter elements are arranged in the Bayer arrangement.

7. A device according to one of claims 4 and 5, wherein said color filter has red filter elements, green filter elements and blue filter elements, and in said (2 x 2) matrix, said green filter elements are positioned on a diagonal line, and said red filter element and said blue filter element are positioned on another diagonal line.

8. A device according to claim 3, further comprising a reduction ratio setting processor that sets a reduction ratio in accordance with which the number of pixel data thinned out by said thinning processor is determined.

9. A device according to claim 1, further comprising a reduced image indicating processor that forms a color image based

on said interpolated image data and indicates said color image.

10. An image reading device in which pixel data of a first image, formed on an imaging device having an on-chip color filter of a plurality of colors, are point-sequentially read from said imaging device and subjected to an interpolation process to generate components of said plurality of colors for each of said pixel data to obtain a second image, said image reading device comprising:

10 a thinning processor that thins out some of said pixel data before said pixel data are subjected to said interpolation process, so that said second image is composed of a smaller number of pixels than said first image.

IMAGE READING DEVICE

5

ABSTRACT OF THE DISCLOSURE

10 The image reading device comprises an imaging device on which an on-chip color filter is provided. The on-chip color filter has color filter elements of the Bayer arrangement, for example. Pixel data, output from the imaging device, are stored in a memory. When the pixel data are read from the memory, some of the pixel data are thinned out, so that a thinned image data, colors of which are arranged in the same arrangement as the color filter elements of the imaging device, is obtained. The pixel
15 data of the thinned image data are subjected to an interpolation process, so that one image's worth of pixel data are generated for each of the color components.

F I G. 1

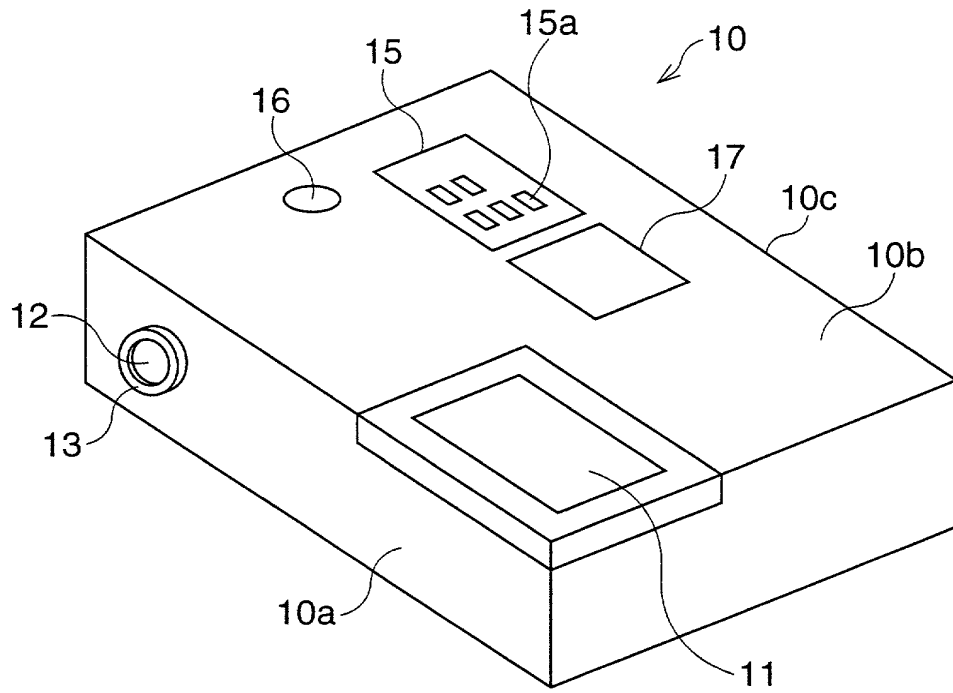


FIG. 2

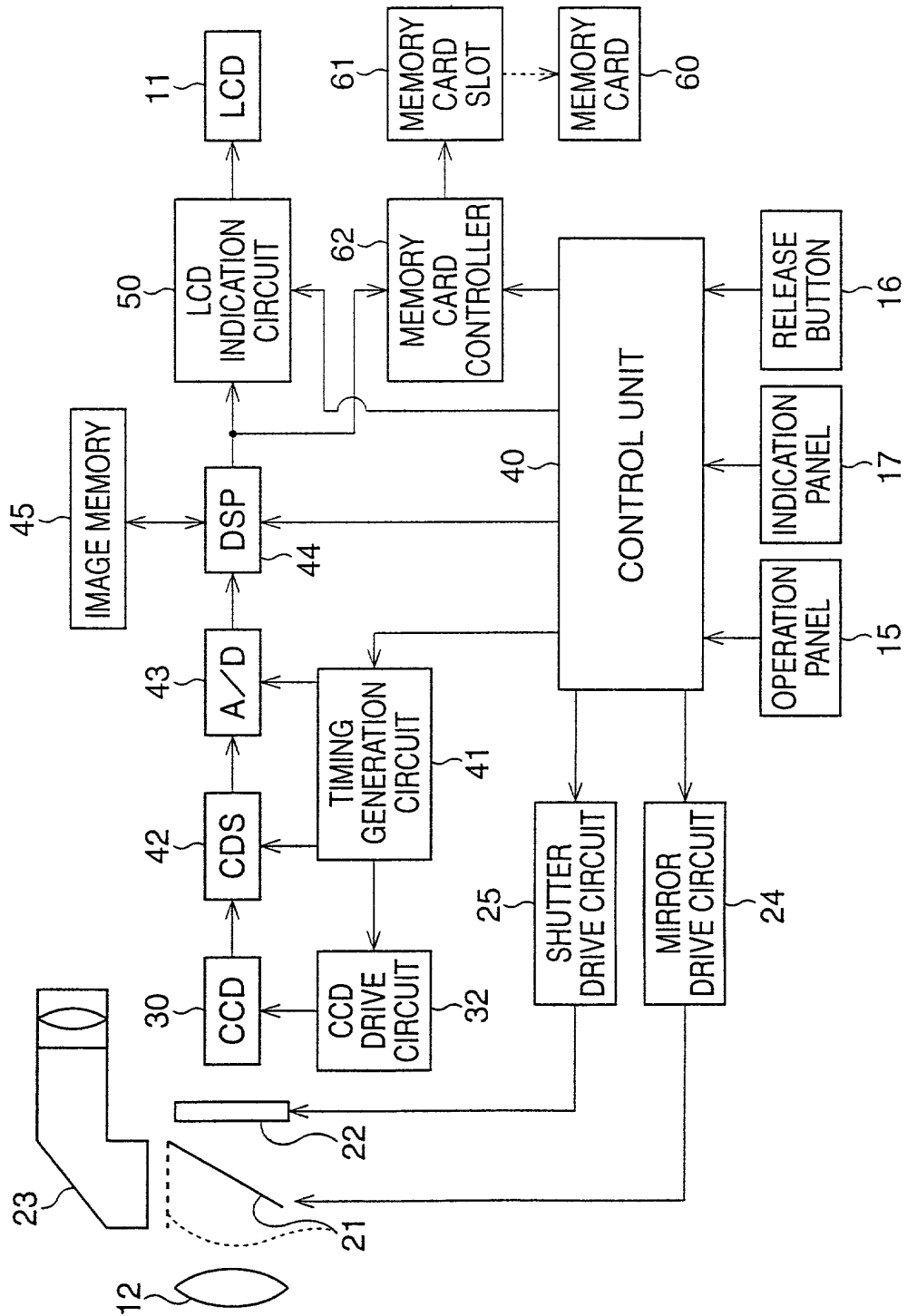


FIG. 3

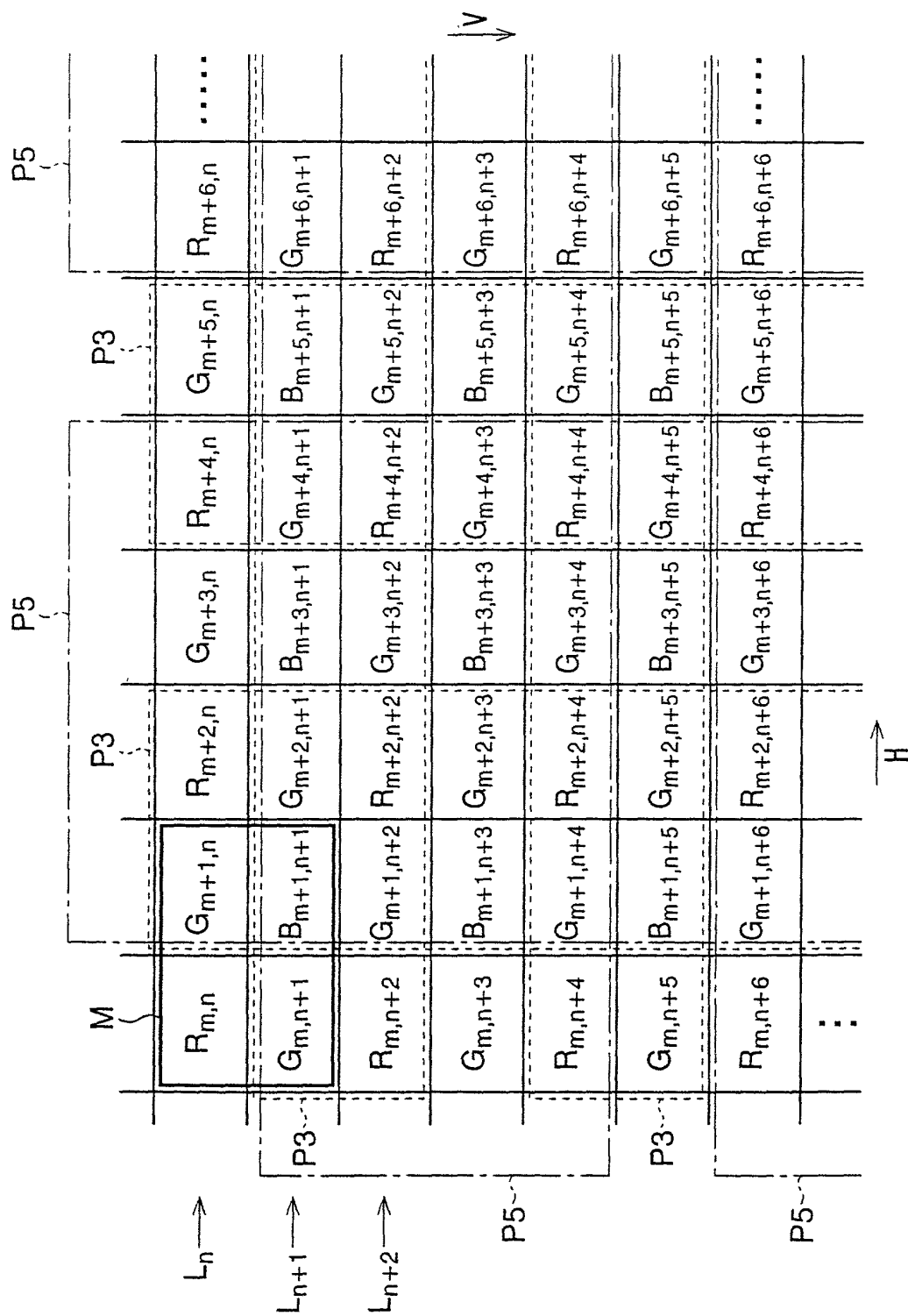


FIG. 4

M

$R_{m,n}$	$G_{m+3,n}$	$R_{m+6,n}$
$G_{m,n+3}$	$B_{m+3,n+3}$	$G_{m+6,n+3}$
$R_{m,n+6}$	$G_{m+3,n+6}$	$R_{m+6,n+6}$

FIG. 5

$R_{m,n}$	$G_{m+5,n}$	$R_{m+10,n}$
$G_{m,n+5}$	$B_{m+5,n+5}$	$G_{m+10,n+5}$
$R_{m,n+10}$	$G_{m+5,n+10}$	$R_{m+10,n+10}$

5 / 6

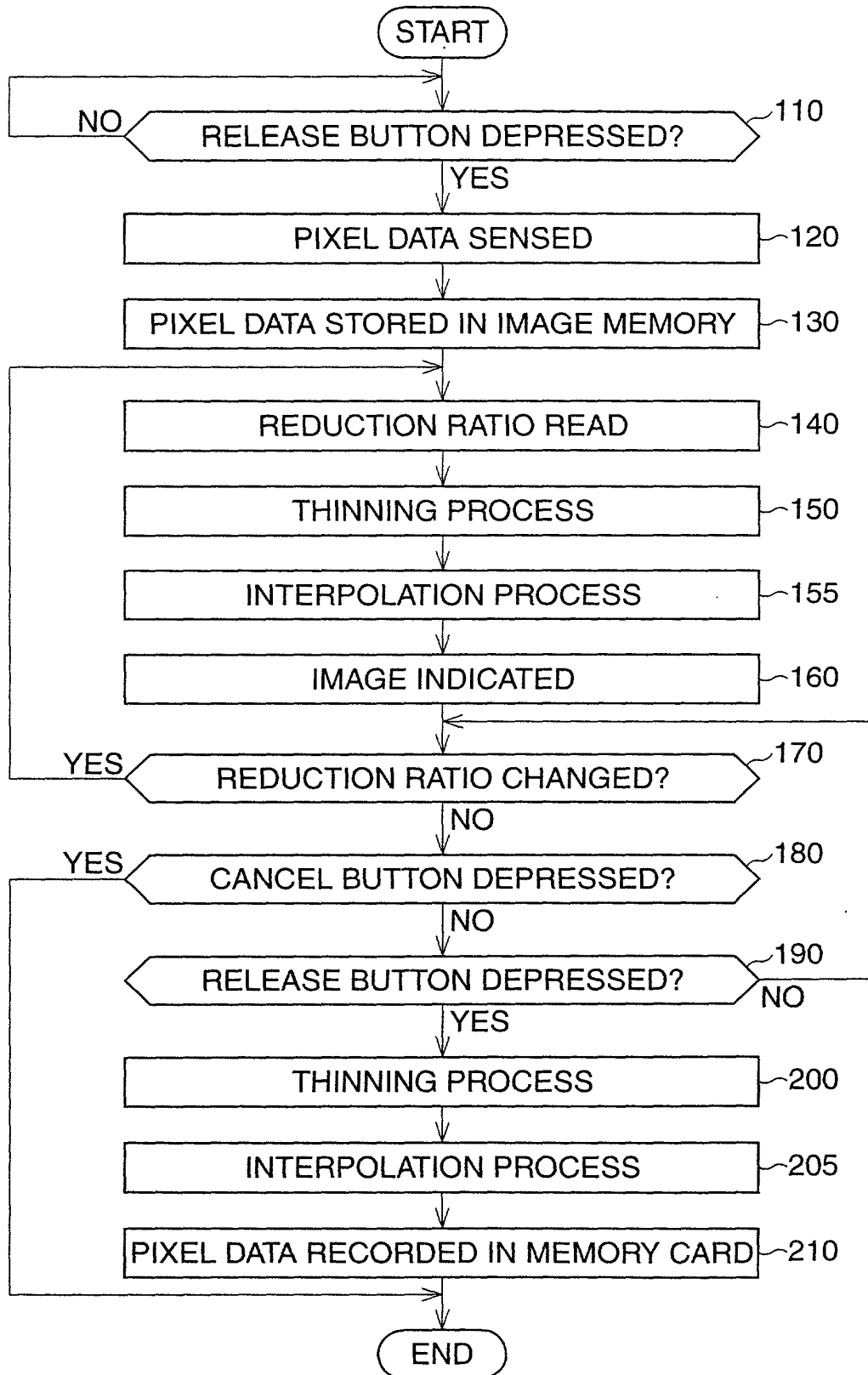
F I G. 6

$R_{m, n}$	$R_{m+3, n}$ •	$R_{m+6, n}$
$R_{m, n+3}$ •	$R_{m+3, n+3}$ •	$R_{m+6, n+3}$ •
$R_{m, n+6}$	$R_{m+3, n+6}$ •	$R_{m+6, n+6}$

F I G. 7

$R_{m, n}$	$R_{m+5, n}$ •	$R_{m+10, n}$
$R_{m, n+5}$ •	$R_{m+5, n+5}$ •	$R_{m+10, n+5}$ •
$R_{m, n+10}$	$R_{m+5, n+10}$ •	$R_{m+10, n+10}$

FIG. 8



Declaration and Power of Attorney For Utility or Design Patent Application

特許出願宣言書

Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり
宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおり
であり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、
最初にして唯一の発明者である(一人の氏名のみが下欄に記載されている
場合)か、もしくは本来の、最初にして共同の発明者である(複数の氏名が
下欄に記載されている場合)と信じ、

その明細書を

(該当するほうに印を付す)

☐ ここに添付する。

☐ _____ 日に 出願番号

第 _____ 号として提出し、

_____ 日に補正した。

(該当する場合)

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討
し、理解したことを陳述する。

私は、連邦規則法典第37部第1章第56条に従い、本題の審査に所要の
情報を開示すべき義務を有することを認める。

私は合衆国法典第35部第119条(a-d)項又は第365条(b)項に基づく、下
記の外国特許出願又は発明者証出願、或いは第365条(a)項に基づく、少な
くとも米国以外の1ヶ国を指名したPCT国際出願の外国優先権利益を主張
し、更に優先権の主張に係る基礎出願の出願日前の出願日を有する外国
特許出願、又は発明者証出願或いはPCT国際出願を以下に明記する：

Prior foreign applications

先の外国出願

P10-341680

(Number)
(番号)

JAPAN

(Country)
(国名)

01/December/1998

(Day/Month/Year Filed)
(出願の年月日)

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated
below next to my name.

I believe I am the original, first and sole inventor (if only one name is
listed below) or an original, first and joint inventor (if plural names
are listed below) of the subject matter which is claimed and for
which a patent is sought on the invention entitled

IMAGE READING DEVICE

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as

Application No. _____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of
the above identified specification, including the claims, as amended
by any amendment referred to above.

I acknowledge the duty to disclose information which is material to
the examination of this application in accordance with Title 37, Code
of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States
Code §119(a-d) or §365(b) of any foreign application(s) for patent
or inventor's certificate, or §365(a) of any PCT international
application which designated at least one country other than the
United States of America, listed below and have also identified
below, by checking the "No" box, any foreign application for patent
or inventor's certificate, or of any PCT international application having
a filing date before that of the application on which priority is claimed:

Priority claimed

優先権の主張

☒

Yes

あり

☐

Yes

あり

☐

Yes

あり

☐

No

なし

☐

No

なし

☐

No

なし

Japanese Language Utility or Design Patent Application Declaration

☐ その他の外国特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto.

私は、合衆国法典第35部第119条(e)項に基づく、下記の合衆国仮特許出願の利益を主張する。

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

(Number) (番号)	(Day/Month/Year Filed) 出願の年月日
------------------	----------------------------------

(Number) (番号)	(Day/Month/Year Filed) 出願の年月日
------------------	----------------------------------

(Number) (番号)	(Day/Month/Year Filed) 出願の年月日
------------------	----------------------------------

☐ その他の合衆国仮特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

私は、合衆国法典第35部第120条に基づく下記の合衆国特許出願、又は第365条(c)項に基づく合衆国を指名したPCT国際出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112条第1項規定の態様で、先の合衆国特許出願又はPCT国際出願に開示されていない限度において、先の出願の出願日と本願の国内出願日又はPCT国際出願日の間に有効となった連邦規則法典第37部第1章第56条に記載の特許要件に所要の情報を開示すべき義務を有することを認める。

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

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☐ Additional U.S. or international application numbers are listed on a supplemental priority sheet attached hereto.

私は、ここに自己の知識にもとずいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽による陳述が本願ないし本願に対して付与される特許の有効性を損なうことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from either his foreign patent agent or corporate representative, if any, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

Japanese Language Utility or Design Patent Application Declaration

委任状： 私は、下記発明者として、下記に明記された顧客番号を伴う以下の弁護士又は、代理人をここに選任し、本順の手続きを遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する。そして全ての通信はこの顧客番号宛に発送される。

顧客番号 7055

現在選任された弁護士は下記の通りである。

Neil F. Greenblum
Bruce H. Bernstein
Roger P. Glass
James L. Rowland
Arnold Turk

POWER OF ATTORNEY: As a named inventor, I hereby appoint the attorney(s) and/or agent(s) associated with the Customer Number provided below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number:

CUSTOMER NUMBER 7055

The appointed attorneys presently include:

Reg. No. 28,394
Reg. No. 29,027
Reg. No. 30,841
Reg. No. 32,674
Reg. No. 33,094

Address: **GREENBLUM & BERNSTEIN, P.L.C.**
1941 ROLAND CLARKE PLACE
RESTON, VA 20191

直接電話連絡先：(名称および電話番号)

Direct Telephone Calls to: (name and telephone number)

GREENBLUM & BERNSTEIN, P.L.C.
(703) 716-1191

唯一のまたは第一の発明者の氏名	Full name of sole or first inventor Koichi SATO	
同発明者の署名	日付	Inventor's signature Koichi Sato November 26, 1999
住所	Residence Saitama, Japan	
国籍	Citizenship JAPAN	
郵便の宛先	Post Office Address c/o ASAHI KOGAKU KOGYO KABUSHIKI KAISHA 36-9, Maenochō 2-chōme, Itabashi-ku, Tokyo, Japan	
第2の共同発明者の氏名 (該当する場合)	Full name of second joint inventor, if any	
同第2共同発明者の署名	日付	Second inventor's signature Date
住所	Residence	
国籍	Citizenship	
郵便の宛先	Post Office Address	

(第6またはそれ以降の共同発明者に対しても同様な情報および署名を提供すること。)

(Supply similar information and signature for third and subsequent joint inventors.)